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On the length of bank-firm relationships: An empirical application to a major French bank

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Abstract

In this paper, we analyse whether the likelihood of the bank-firm relationships ending is dependent on their age or not and whether the respective behaviour is smooth or changes over their length. A parametric duration analysis is employed in this analysis. We start by estimating a continuous-time Weibull duration model over the duration of the relationships between 1185 firms and one of the major French banks. Our findings show that the likelihood of the relationships between them ending increases over their duration, but other specific factors to the firms, to the bank, to their own relationship and certain pricing conditions also play an important role in the duration of those relationships.

Additionally, we extend the baseline Weibull duration model in order to allow for change-points in the duration dependence parameter. The empirical findings support the presence of a change-point: positive duration dependence is observed for those relationships that last less than 23 years, but no evidence of duration dependence is found for longer events. Hence, we conclude that the likelihood of these relationships ending increases over time, but only until about 23 years of duration; then the relations become stronger and the likelihood of they ending is no longer dependent on its duration but on other conditionings.

Keywords: Bank-firm relationships, duration analysis, duration dependence, change-points.
JEL classification: C41, G21.

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1. Introduction

One of the most important roles of banks, that explain their presence in the economy, is their capacity to reduce information asymmetry in the credit market (Diamond, 1984). This feature of the banking sector relies on the capacity of financial institutions to build up long-term relationships with opaque customers such as small and medium-sized enterprises (SME), through which they collect private information about them in order to cope with the information asymmetry problem. Indeed, following repeated interactions with firms over time, banks accumulate private information – especially soft information – and build up closer relationships with them (Boot, 2000). Therefore, thanks to these lending relationships, inefficiencies linked to the imperfections of information between lenders and borrowers will be reduced and this will allow banks to deal with misleading decisions and reduce credit rationing problems (Diamond, 1984; Allen, 1990; Boot, 2000).

Applied empirical analyses have used several indicator variables to identify the lender-borrower relationships. Common proxies for these relationships are: (i) the duration of those relationships (the length); (ii) the strength of the lender-borrower ties, measured by the number of products and services provided by banks to their client (the breadth); (iii) and the number of firms' bank relationships (the exclusivity). These variables are introduced to analyze the effect of the relationships intensity on the availability, terms, and quality of corporate loans (Petersen and Rajan, 1994; Degryse and Cayseele, 2000; Elsas, 2005; Cotugno et al., 2013). Despite this field comprise a large number of empirical works, only a few studies investigate the determinants and characteristics of those variables on banking relationships. A duration analysis is employed by Ongena and Smith (2001a), Karceski et al., (2005) and Farinha and Santos (2002) to explore the effect of firm-specific variables on the likelihood of bank relationships ending or switching from single to multiple ones. They find that those likelihoods tend to rise with the length of those relationships. Furthermore, they also show that profitable, highly leveraged and small firms, as well as those with multiple bank relationships, maintain shorter bank relationships. However, these findings are contradicted by some studies, in particular, because opaque borrowers – such as small and medium-sized firms – tend to become trapped in their relationships with the respective banks due to their informational constrains and large switching costs (Sharpe, 1990; Kim *et al*., 2003; Von Thadden, 2004; Gehrig and Stenbacka, 2007).

The purpose of this study is to contribute to this small strand of the empirical literature on the determinants of the bank-firm relationships. Our analysis complements and extends the existent empirical works in several ways. First, following Ongena and Smith (2001a) and Karceski et al., (2005), we use a duration analysis to explore the determinants of the likelihood of a bank-firm relationship ending. Second, we improve upon Ongena and Smith's (2001a) and Karceski et al., (2005) work in terms of the econometric method used and by adding a range of time-series relationship-specific information about the lender and their clients: important firm and bank specific characteristics, pricing and economic conditions are considered in this analysis. Third, we go a step forward in testing whether the likelihood of bank-firm relationships are duration dependent or not, i.e., whether the likelihood of they ending is increasing or decreasing (or stable) over time and try to identify the similarities (or differences) with respect to firm size. Fourth, this study provides, for the first time in this field of research, an analysis to the presence of change-points in the duration of the bank-firm relationships, i.e. we test whether the degree of the likelihood of a relationship ending as it gets older may change after a given duration.

To address these issues, we estimate a Weibull duration model over the duration of the relationships between 1185 firms and an important French bank. Our findings show that the likelihood of those relationships ending increases over their duration, which confirms the evidence provided by Ongena and Smith (2001a) and Karceski et al., (2005) for a group of Norwegian firms. Other specific factors to the firms, to the bank, to their relationship and pricing conditions have also showed to play an important role in the duration of those relationships.

Next, we extend the baseline Weibull duration model in order to allow for the presence of a change-point in the duration dependence parameter. This novel approach provides interesting results supporting for its presence: positive duration dependence is observed for those relations that last less than 23 years, but negative or no duration dependence is found for longer events. This means that bank-firm relationships become stronger when they last more than a quarter of a century and, from there onwards, other factors may play a more detrimental role in their duration than their own age. This represents a remarkable new finding to the literature which contributes to a better understanding of the duration of bank-firm relationships.

The rest of the paper is organized as follows. Section 2 reviews the existing literature on banks and firms relationships. Section 3 presents the econometric models. Section 4 describes the data and the variables. The empirical analysis and the discussion of the results are presented in Section 5. Finally, Section 6 concludes.

2. Literature Review

Financial intermediation literature proposes several definitions for the firm-bank relationship (Berger, 1999; Boot, 2000; Berger and Udell, 2002). Boot (2000) defines the lender-borrower relationship as the supply of financial services by a financial institution that has the following characteristics: (i) on the one hand, the lender must invest in getting borrower-specific information; (ii) on the other hand, the lender has to assess the relevance of these investments throughout multiple interactions with the same borrower over time and across various products.

Existing literature emphasizes on the one hand both the advantages and disadvantages of relationship lending and on the other hand investigates the effect of bank-firm relationships on the firms' loan conditions. These studies show that the length of the relationship lending improves the credit availability for the firms (e.g. Petersen and Rajan, 1994) even during a credit crunch period (Cotugno et al., 2013), and reduces the likelihood of firms to provide collateral (e.g. Pazzolo, 2004). However the impact of long-term relationships on the credit cost is not obvious in the literature. Some empirical works find that credit cost rises as the length of banking relationship increases (e.g. Degryse and

Ongena, 2005), while other analysis show a negative link between the relationship lending and loan pricing (e.g. Berger et al, 2007).

Empirical studies on the field of relationship lending combine several indicator variables to identify the lender-borrower relationship. The duration of bank-borrower relationship is the most frequently used in empirical work (e.g. Degryse and Ongena, 2007; Bellucci et al., 2013). The underlying idea is that the intensity of the relationship between the bank and its customer increases with time across multiple contacts between them during this period. These multiple interactions with its borrower allow the bank to gather private information, reduce information asymmetry and strengthen the relationship with the borrower. The second proxy commonly used by empirical literature to characterize the strength of relationship between a lender and its borrower is the exclusivity of the relationship between the firm and the bank. The use of this variable by applied empirical studies is based on the presumption that because of exclusivity the relational lenders benefit from a softening of banking competition. This encourages the bank to invest more in obtaining customer-specific information, and these results in a better collection and use of valuable private information, which promotes the development of close ties between the lender and the firm. Hence, exclusivity facilitates the achievement of the economic advantages of the lending relationship (e.g. Petersen and Rajan 1995; Cotugno et al., 2013). The last variable used by literature to analyze this issue measures the breadth of the firm-lender relationship by considering the scope of this tie through the number of services provided by the bank to the borrower. The use of this variable is consistent with the notion that multiple interactions with the borrower, often through providing multiple financial services, allows banks to accumulate additional information on the borrower that improves their ability to assess and monitor customers (e.g. Degryse and Cayseele, 2000; Bellucci et al., 2013).

Thereby, the studies in the field of lender-borrower relationships fosters extensive works that explore the advantages and disadvantages of lending relationships for firms as well as the effect of relationship intensity on the availability, conditions and quality of corporate loans. However, only few studies investigate the determinants of the proxies used to identify the firm-borrower relationship. Thus, our analysis complements and extends the results of works exploring the key factors of bank-firm relationships. By assessing the determinants of the length of bank-firm relationships with a proper duration analysis, we think we contributed relevantly to this studies filed on one of its most important dimensions.

Having flourished in the engineering and medical fields, the duration analysis rapidly spread out to other sciences. In economics, it started to be employed in labour economics to assess the duration of periods of unemployment.[1] It has also been widely used in the analysis of the duration of the business cycle phases.[2] A basic Weibull model is usually employed in those studies with the aim of finding duration dependence in the phases of the business cycle, i.e. whether the likelihood of expansions and recessions ending is dependent on its age or not. However, this model assumes that the behaviour of duration dependence is smooth over the entire duration of the event, which may not be true. Given this limitation, Castro (2013) adapts the Weibull model with change-points proposed by Lara-Porras et al. (2005) to the analysis of the duration of the business cycle phases. This author shows that positive duration dependence in expansions is no longer present when they last more than ten years, which proves the presence of a change-point in the duration of economic expansions.

Other studies also show the presence of duration dependence in different dimensions of the economy. Bracke (2011) and Cunningham and Kolet (2011) show that the likelihood of housing booms and busts ending is positively dependent on its age. More recently, Agnello et al. (2013) provide some evidence indicating that fiscal consolidations are also duration dependent and Castro and Kubota (2013) uncover the presence of positive duration dependence in credit booms. On the political field, Castro and Martins (2013) also

[1] See Allison (1982) and Kiefer (1988) for a review of the literature on duration analysis.

[2] See, for example, Sichel (1991), Zuehlke (2003), Davig (2007) and Castro (2010, 2013).

find positive duration dependence in local governments' tenure, i.e. the more time a party remains in office, the higher is the likelihood of leaving it.

Due to its properties, this kind of analysis is also suitable for studying the duration of bank-firm relationships. Hence, we employ a Weibull model to investigate the presence of duration dependence in a large group of bank-firm relationships. Additionally, we also control for the presence of change-points in the structure of the model. In the next section, we describe the application of these models to this study. This analysis represents an important contribution to the economic literature in this field and it intends to contribute to a better understanding of those relations.

3. Econometric models

In this section, we describe the duration models employed in the empirical analysis. The general aspects of a duration analysis are described first, followed by the description of the basic Weibull model and its extension to the case where change-points are allowed.

3.1. Duration analysis

The duration variable is defined as the number of periods (months) a hank-firm relationship lasts. If T measures the time span between the beginning of a relation and its end, then $t_1, t_2, \ldots, t_n$ will represent its observed duration. The probability distribution of the duration variable, T, can be specified by the cumulative distribution function, $F(t)=\Pr(T<t)$, and the corresponding density function is $f(t)=\mathrm{d}F(t)/\mathrm{d}t$. Alternatively, the distribution of T can be characterized by the survivor function, $S(t)=\Pr(T\geq t)=1-F(t)$, which measures the probability that the duration of a relationship is larger or equal to t.

A particularly useful function for duration analysis is the hazard function, $h(t) = f(t)/S(t)$, which measures the rate at which the bank-firm relationship spells end at time t, given that they lasted until that moment. In other words, it measures the probability of exiting from a state in moment t conditional on the length of time in that state. This function helps to characterize the path of duration dependence. For instance: (*i*) if d$h(t)$/d$t>0$ for $t=t^*$, there is positive duration dependence in t^*; (*ii*) if d$h(t)$/d$t<0$ for $t=t^*$, then there is negative duration dependence in t^*; and (*iii*) if d$h(t)$/d$t=0$ for $t=t^*$, there is no duration dependence. Therefore, when the derivative of the hazard function with respect to time is positive, the probability of a relationship ending in moment t, given that it has lasted until t^*, increases with its age. Thus, the longer the relationship is, the higher the conditional probability of its end will be.

From the hazard function, we can derive the integrated hazard function, $H(t)=\int_0^t h(u)du$, and compute the survivor function, $S(t)=\exp[-H(t)]$. While different parametric continuous-time duration models can measure the magnitude of duration dependence and the impact of other time-invariant variables on the likelihood of an event ending, the most commonly used functional form of the hazard function is the proportional hazard model:

$$h(t,x)=h_0(t)\exp(\mathbf{x\beta}) \tag{1}$$

where $h_0(t)$ is the baseline hazard function that captures the data dependence of duration and represents an unknown parameter to be estimated, $\boldsymbol{\beta}$ is a (k×1) vector of parameters that need to be estimated and $\mathbf{x}$ is a vector of covariates. The proportional hazard model can be estimated without imposing any specific functional form to the baseline hazard function (the so called "Cox model"). Given the inappropriateness of this procedure (in particular, for studying duration dependence), a popular alternative imposes a specific parametric form for the function $h_0(t)$, i.e. the "Weibull model".

3.2. The basic Weibull model

The Weibull model is characterized by the following (baseline) hazard function:

$$h_0(t)=\gamma p t^{p-1} \tag{2}$$

where p parameterizes the duration dependence, t denotes time, γ is a constant; moreover, $p>0$ and $\gamma>0$. If $p>1$, the conditional probability of a relationship ending increases as the it gets older, i.e. there is positive duration dependence; if $p<1$ there is negative duration dependence; finally, there is no duration dependence if $p=1$.[3] Therefore, by estimating p, we can test for the presence of duration dependence in the bank-firm relationships.

Inserting the Weibull specification for the baseline hazard function, as expressed by equation (2), in the proportional hazard function denoted by (1), we get:

$$h(t,x) = \gamma p t^{p-1} \exp(\mathbf{x\beta}) \tag{3}$$

Hence, the corresponding survivor function can be written as:

$$S(t,\mathbf{x}) = \exp[-\gamma t^{p} \exp(\mathbf{x\beta})] \tag{4}$$

This model can be estimated by Maximum Likelihood and the log-likelihood function, for a sample of $i=1,\ldots,n$ bank-firm relationships, is given by:

$$\begin{aligned} \ln L(\cdot) &= \sum_{i=1}^{n} [c_i \ln h(t_i,\mathbf{x}_i) + \ln S(t_i\mathbf{x}_i)] = \\ &= \sum_{i=1}^{n} [c_i(\ln \gamma + \ln p + (p-1)\ln t_i + \mathbf{x}_i\boldsymbol{\beta}) - \gamma t_i^{p} \exp(\mathbf{x}_i\boldsymbol{\beta})] \end{aligned} \tag{5}$$

where c_i indicates when observations are censored. If the relationship remains until the end of the sample period under analysis (March 2013), those observations are censored (i.e. $c_i=0$); when they are broken during the sample period, they are not censored (in that case, $c_i=1$).

3.3. A Weibull model with change-points

While the basic structure of the log-likelihood function for the Weibull model allows us to analyze the presence of duration dependence in the bank-firm relationships, we also move a step further in that we assess the extent to which the likelihood of a relationship ending as it gets older changes after a certain duration. Thus, we allow for the possibility of a structural break in the Weibull model and conjecture that the parameters of the baseline hazard function (p and γ) can change at a certain point (i.e. the "change-point") in time. In particular, we expect that the degree of duration dependence, p, changes after the

[3] In this third case, the Weibull model is equal to an Exponential model.

event has lasted more than a certain time. Consequently, we do not only expect that the likelihood of a bank-firm relationship ending increases over time, but also that if it has lasted more than a certain time, the likelihood of ending may change significantly after that point, that is, the magnitude of duration dependence may decrease or increase from that point onwards.

We propose here an alternative Weibull model, for the duration of bank-firm relationships, with a change-point that follows the general model framework developed by Lara-Porras et al. (2005) and Castro (2013) for cases where the Weibull distribution, or the respective parameters characterizing the baseline hazard function, varies over time for different intervals, but remain constant within each interval. For simplicity, let us re-write equation (2) as:

$$h_0(t) = \gamma p t^{p-1} = \lambda p (\lambda t)^{p-1} \tag{6}$$

where $\gamma=\lambda^p$. Hence, the survival function becomes:

$$S(t, \mathbf{x}) = \exp[-(\lambda t)^p \exp(\mathbf{x}\boldsymbol{\beta})] \tag{7}$$

Denoting $g(t)=\ln H(t)$ and considering a change point, τ_c, and two intervals, $t_0<t\leq\tau_c$ and $\tau_c<t\leq t_T$, $g(t)$ can be expressed as:

$$g(t) = \ln(\lambda_j t)^{p_j} \tag{8}$$

with j=1 or j=2. Due to the fact that the continuity of $g(t)$ in the change-point, τ_c, has to be verified, we must impose that:

$$\ln(\lambda_1 \tau_c)^{p_1} = \ln(\lambda_2 \tau_c)^{p_2} \tag{9}$$

Solving this equation with respect to p_2, we get:

$$p_2 = p_1 \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)} \tag{10}$$

Consequently, in the case of the survival time ending in the first interval, we have:

$$g(t)_{j=1} = p_1 \ln(\lambda_1 t) \tag{11}$$

and, similarly, for the survival time ending in the second interval:

$$g(t)_{j=2} = p_2 \ln(\lambda_2 t) = p_1 \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)} \ln(\lambda_2 t) \tag{12}$$

Considering the *i*-th spell (or relationship), we get:

$$g(t) = d_i p_1 \ln(\lambda_1 t_i) + (1 - d_i) p_1 \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)} \ln(\lambda_2 t_i) \tag{13}$$

where d_i=1 if j=1 or, more precisely, $t_0<t\leq\tau_c$, d_i=0 if j=2, i.e. $\tau_c<t\leq t_T$, and i=1,2,...,n, i.e. the number of relationships identified in our dataset.

Since $H(t_i,\mathbf{x}_i)=\exp[g(t_i)+\mathbf{x}_i\boldsymbol{\beta}]$, the hazard function is, therefore, given by:

$$\begin{aligned} h(t_i, \mathbf{x}_i) &= dH(t_i, \mathbf{x}_i)/dt_i = g'(t_i) H(t_i, \mathbf{x}_i) = \\ &= d_i \frac{p_1}{t_i} + (1 - d_i) \frac{p_1}{t_i} \frac{\ln(\lambda_1 \tau_c)}{\ln(\lambda_2 \tau_c)} H(t_i, \mathbf{x}_i) \end{aligned} \tag{14}$$

Attending to the relation between the survivor function and the integrated hazard, $S(t_i, \mathbf{x}_i) = \exp[-H(t_i, \mathbf{x}_i)]$, the log-likelihood function can be written as:

$$\ln L(\cdot) = \sum_{i=1}^{n} \{ c_i [\ln g'(t_i) + g(t_i) + \mathbf{x}_i \boldsymbol{\beta}] - \exp[g(t_i) + \mathbf{x}_i \boldsymbol{\beta}] \} \tag{15}$$

where $g'(t) = d_i \frac{p_1}{t_i} + (1 - d_i) \frac{p_1}{t_i} \frac{\ln(\lambda_1 t_c)}{\ln(\lambda_2 t_c)}$. This model is estimated by Maximum Likelihood, given a particular change-point τ_c. The relevance of the change-point is evaluated by testing whether there is a statistically significant difference between p_1 and p_2, i.e. whether the duration dependence parameter changes significantly between the two sub-periods.

4. Data and definition of the variables

The dataset used in this study is unique and is retrieved mainly from one of the major universal French banks. The French economy is well suited to deal with this issue given that it is a bank-based financial economy where bank financing predominates. We got access to a random sample of 3616 annual loan officers' credit assessment reports about firms' credit worthiness over the period from January 2008 to the end of March 2013. The loan officer's credit assessment report is a document, produced annually by the loan officer in charge of managing the customer relationship in order to evaluate the creditworthiness of the firms. The document contains relevant updated data about the bank-firm relationship and includes a loan officer analysis on the financial health of the enterprise as well as information regarding the business side of the relationship. This document is considered as one of risk management tools used by the bank for corporate market. It is also used by the loan officer for monitoring the bank's commitments with the clients. For each new firm's relationship, the credit assessment report is prepared. The report must be updated at least once a year by the loan officers, managing the relationship within the framework of regular monitoring of counterparties as well as in the case of a new firms' funding. Our data concerns loan officers' assessment of the corporate relationship in the framework of the annual update or in case of newly granted credit. Therefore, through loan officer's credit assessment report, we got access to detailed information on various firm-level characteristics, pricing conditions, and individual bank-borrower relationship variables over time. Further, we also obtain data regarding the bank market power on the corporate credit market. Thus, we get information on the bank's market share of corporate loans relative to the geographical location of the firms' in tie with the bank over the studied period. This information is quarterly data provided by the French Central Bank to each bank granting credit at the level of French department (geographical location). We also use information from Bankscope database provided by the Bureau Van Dijk to calculate the Lerner index of the bank. Finally, we use DIANE database, a database about French firms to access information on some firm's specific characteristics as well as firm's balance sheets. The SIREN number was used to identify each firm' present in our dataset in DIANE database. The database used in this study concerns only firms that are considered as opaque and subject to a high level of information asymmetry. This feature of the firms increases their reliance to banks loans and therefore leading to relationship lending technology. In the data set, every relationship is managed by banks' loan officers in terms of screening firms' credit application and monitoring outstanding loans. Indeed, recent studies emphasize the role of bank-loan officers in producing private information, the key element of the bank-firm relationships (e.g. Bouchellal, 2013; Uchida et al., 2012). Furthermore, the organizational structure of the bank from which we collect data, allows the gathering of customer-private information that is important element to establish and maintain firm-bank relationships (e.g., Stein, 2002; Berger and Udell, 2002; Berger et al., 2005). It is clear that the use of data retrieved from one bank presents some limitations because it does not allow us to consider different bank behaviors in French corporate loan market. However, it seems that this is the only way to collect very detailed and accurate information relative to this issue given the privacy of the borrower-lender relationship.

Finally, the complete database contains 1185 observations. Each observation represents one firm-bank relationship and for each one, the duration of its relationship with the bank is computed. The dataset includes 303 observations related to large firms and 882 observations concerning small-and medium-sized enterprises (SME). We define the duration relationship as the number of consecutive months from the date of the relationship beginning to the date of loan officer's assessment. Bank's corporate department produces every month, the list of the financial institution's remaining firm relationships. Once, the firm is dropped from the bank's list clients, it is identified, to have ended the relationship with bank. We find such 92 bank-firm relationships in our sample from January 2008 to the end of March 2013.

Our objective is to examine whether the likelihood of the bank-firm relationship ending depends on the length of time that the relationship lasts, i.e. whether there is duration dependence or not. For this purpose, we employ a parametric duration analysis. However, besides the presence of duration dependence, other variables may influence the duration of the bank-firm relationship. For each relationship spell we extract information on various firm-level characteristics, lender market power, pricing conditions, individual bank-borrower relationship variables, and business climate. The list of variables used in this study, the respective description and expected signs are presented in Table 1.

[Insert Table 1 around here]

The first group of variables to be considered is related to the characteristics of the firm: size, age, sector, turnover, profit, default probability and transparency. In order to distinguish between large firms and small-and medium-sized enterprises (SMEs) in our sample we use a dummy variable that takes value 1 when the firm is large and 0 otherwise (*LargeFirm*). We follow the EU definition of large companies so a firm is considered as large when it has more than 250 employees. Large firms are usually more transparent which reduces their reliance on bank funding and enables them to start a new bank relationship more easily. Moreover, they also, enjoy higher bargaining power to negotiate with the bank for its best interest and they can also be offered better conditions by other banks that see as an opportunity to have them in their portfolio. Furthermore, the monitoring of large firms is based on the use of public information, “hard information”, which does not strengthen the tie with the customers (e.g. Berger et al., 2005). Thus, we expect that the bank-firm relationship can be shorter when large firms are involved in a relationship with a bank.

The age of a firm (*FirmAge*) may also be closely linked to the duration of its relationship with a bank but its effect remains ambiguous. Older firms are usually more stable and integrated in the market, so the risk of disappearing or shutting down is lower. This facilitates the establishment of new relationships for older firms. Hence, we may expect that the age of firm has a positive effect on the probability of ending an existing relationship. However, firms’ age facilitates various types of information exchange between the borrower and the lender, thus when firms survive in the market and accumulate a significant repayment history, these older firms develop a good reputation and tend to benefit from greater credit availability and better credit terms than the younger ones (Petersen and Rajan,1995, Sakai et al.,2010). Therefore, a firm’s age may make the relationship longer.

Regarding the sector in which the firm is operating, we do not have any prior expectation on whether it may have a positive or negative impact on the duration of the relationship. To control for those possible sector effects, we aggregate the firms into five sectors: commerce (*Trade*), industrial (*Indus*), services (*Serv*), construction (*Constr*) and agriculture (*AAI*). Consequently, five dummies were generated and the first four are included in the model, keeping the *AAI* as the basis category.

We control for the effect of firms' size and profit by measuring, respectively, the impact of the firm's logarithm of the turnover (*LnTurn*) and logarithm of profitability (*LnProfit*) on the duration of the bank-firm relationship. The firm's turnover and profitability provide an indication of the firm's ability to generate resources and to repay its loans. These two aspects allow firms with high turnover and profitability to enhance their pricing conditions and to suffer less from "the hold-up problem". Thus, we may expect a negative sign for the coefficient, which means that firms with a higher turnover and/or higher profits tend to have a longer relationship with the bank.

The probability of default (*DefaultProb*), the result of the bank's internal credit rating computed by loan officers using soft and hard information at their disposal, is another specific characteristic of a firm that may have an impact on the duration of the bank-firm relationship. Indeed, this procedure involves the use of audited financial statements of firms, tax return and payment information, as well as non-financial factors such as firms' owners' character, their managerial capabilities and the market positioning of a firm. The expected sign can be positive or negative. On one hand, given that the probability of default that we use resulted from the combinations of hard information and specific private information about the firm, we can conjecture that the bank will prefer to make business with those firms that have a lower risk of default. Therefore, those relationships are the ones that we expected to be long-lasting. On the other hand, the economic literature suggests that banks use relationship technology to fund young and more risky firms (Petersen and Rajan; 1995). Likewise, firms with a higher probability of failure should suffer more from informational hold-up problems which mean that such firms rely more on the relationship lending (Rajan, 1992; Santos and Winton; 2008). Therefore, we may also expect that firms with high probability of default try to keep longer relationships with the bank.

We also include a variable that proxies for the firm's transparency (*Transparency*). It is a dummy variable that takes value 1 when the legal status of the company requires a board of directors and a periodic publication of audited financial statements. The underlying idea is that transparent firms relay less on the bank relationship given their ability to build easily a new tie with another lender. Also, banks use relationship technology mainly with opaque firms (Berger and Udell; 2006). Thereby, we expect a firm's transparency to lower the duration of the relationship.

Regarding the characteristics of the bank, we employ the market share of corporate loans (*MktShare*) as a proxy for the bank's market power, the Lerner index (*LernerIndex*) to control for the level of banking competition.[4] The Lerner index is a commonly used competition indicator which measures the banks' ability to price their products above their marginal cost. The index takes a value between zero and one: zero in the situation of perfect competition and one in the case of monopoly. Hence, the index decreases as the degree of competition increases. As for (*MktShare*) variable we use the latest data produced by the French Central Bank and available for the loan officer at the time of assessment. The bank's market power represents an important factor that can produce the ending of the bank relationship through its influence on bank's pricing of firms' loan, the "hold-up problem" (Sharpe, 1990; Rajan, 1992). However, building a relationship with customers is costly and banks must have warranties to achieve the required return on investment and keep the customer in relationship at least until they cover the cost. Thereby, Petersen and Rajan

[4] We compute the Lerner index of the bank from which we retrieved data as the difference between price of total assets and marginal costs of total assets expressed as a percentage of price of total assets: $LernerIndex_{it} = \frac{P_{it} - Cm_{it}}{P_{it}}$. The price of total assets P_{it} is calculated as the ratio of the bank revenue to total assets; the marginal costs Cm_{it} are estimated from a translog cost function with a single output (total assets), three inputs (the fund costs, capital costs and labor cost) and three netputs (fixed assets, provisions for "bad" debts and capital). See appendix A for a detailed specification of the translog function used.

(1995) provide theoretical and empirical evidence supporting the hypothesis that market concentration is a necessary condition for a financial institution to use the relationship technology, though Degryse and Ongena (2007) provide evidence that market power and relationships are not necessarily inimical. Therefore, it is difficult to anticipate the effect of this variable on the probability to terminate the relationship because both positive and negative signs are possible. By similar reasons, it is also difficult to predict the impact of the level of banking competition on the duration of banking-firm relationships.

The other important element that can influence the duration of bank-firm relationships are the pricing conditions proposed by the bank to their clients. Therefore, we use variable (*BankIncome*) which controls for the whole lender income from its relationships with each firm over the last twelve months before the date of loan officers' assessment of the corporate. Likewise, it would be interesting to test the effect of different components of the bank's earnings from its relationships on the respective duration of these relations. So, we consider the net earnings of the bank from its relation with the firm including all sources of the bank revenue such as its prior credit extension (*BKIncCrdMLT and BKIncCrdST*), its saving services (*BKIncSaving*), and the sale of arm's length services to the firm *(BKIncArm)*. On one hand, returns from credit and saving activities might be negatively related to the likelihood of those relationships ending, while on the other hand, bank's revenue from the arm's length services sale to corporates might be positively related to the duration of those relationships. Indeed, intensive credit and saving activities between the bank and its client demonstrate a strong link between the two parties given their informational contribution for the lender which means that they tend to last longer when the bank's earnings are higher. However, an important component of bank's income from transactional activities with the firm (*BKIncArm)* shows that the tie between the two parts is rather a transactions-based lending which weakens the bank-firm relationship and increases the likelihood of its termination.

Additionally, we also consider some additional variables that characterize the bank-firm relationship: the number of bank relationships of the firm (*Relations*), the bank's share of the total firm's banking debt (*FinShare*), a proxy of the physical distance between the firm and the bank (*Distance*) and two variables for the assessment of the firms quality concerning the respective "soft" and "hard" information collected by the bank (*SoftInfo* and *HardInfo*).

The influence of the number of bank relationships of the firm on the bank-firm relationship duration is based on the assumption that maintaining an exclusive bank relationship strengthens the tie between the financial institution and the customer (Degryse and van Cayseele, 2000; Cutugno et al., 2013). Indeed, exclusivity softens the competition for the relational bank, makes it the only bank with access to firm specific information and allows it to benefit from the economic advantages associated with relationship technology. Thakor (1996) proves theoretically that the existence of multiple relationships reduces the value of information acquisition by any one bank. Therefore, we expect that the higher the number of relations, the lower the bonds between the bank and the firms will be and, therefore, the higher will be the probability of the bank-firm relationship ending.

Another important conditioning element of the bank-firm relationship is the bank's share of total debt financing of a firm (Elsas, 2005). A higher share of banking credit supplied to the firm by the financial institution is a sign of a particular, strong and intensive tie between the firm and the bank. Indeed, a high level of credit transactions between the bank and the firms allows more acquisition of valuable information and, therefore, enhances the bargaining power of the lender by increasing the switching cost of the borrower in case he tries to substitute the lender for another bank. Hence, we conjecture that the higher the value of this financial share is, the longer the duration of the respective relationship will be.

It is important to note that the number of creditors of the firm is often a corporate decision, so we use the number of bank relationships of the firm (*Relations*) as demand-side determinants of the firm-bank relationships. At the same time, we control for supply-side determinants of lender-firm relationship by using the share of banking credit supplied to the firm by the financial institution (*FinShare*).

Nevertheless, another important factor that may influence the bank-firm relationship's duration – which has been widely discussed in financial literature – is the geographical distance between the financial institution and the customer. Two channels of physical distance through which it may affect the bank-firm relationship duration are identified by banking theory: the informational channel (Hauswald and Marquez, 2006) and the transactional costs channel (Sussman and Zeira, 1995). However, the two strands of the economic theory assume that distance decreases the tie between a bank and a potential client. To consider the effect of distance on the duration of the bank-firm relationship, we introduce a dummy variable that takes value 1 when the headquarters of the firm are not in the same department (French administrative geographical division) of the loan officer's branch of the bank and 0 otherwise (*Distance*). We expect that the longer the distance is between them, the shorter will be the relationship.

We also control for the information that the bank gathers about their costumers, in particular, regarding the assessment it makes on the firm's quality using private information collected by loan officers ("soft" information) and regarding the credit score it assigns to the firms based on audited financial statements ("hard" information). We expect a negative sign for the coefficient on the first one, but a positive for the second.

To complete our analysis, we include in the model a proxy to control for the economic environment at the date when the loan officer analyses the firms' creditworthiness. The variable used is the monthly sentiment index for the business climate (*BusClimate*). This variable is computed by French National Institute of Statistics and Economic Studies (INSEE) for each type of industry to control for the general economic environment that firms confront. The business climate of the firm's activity sector is an important element to anticipate the borrower's future financial health and his ability to repay loans. For this reason we add the Business Climate Index control variable which is a leading indicator for economic activity in France, prepared by the French National Institute of Statistics and Economic Studies (INSEE). We expect a positive sign for the coefficient on this variable because when the economic environment deteriorates, some firms are expected to have more difficulties in obtaining revenues and resources to finance their activity. Hence they tend to rely more on banking loans to face those cash-flow difficulties (e.g. Cotugno et al., 2013). This means that they will depend more on their relationship with the bank, which may increase the likelihood of a long term bank-firm relationship. The banks also have interest in keeping this relationship given that they expect to profit from the respective loans they concede (Santos and Winton, 2008).

The descriptive statistics for these variables are presented in Table 2. For each one we have the number of episodes or relationships identified (No. Obs.), their mean duration (Mean), standard deviation (Std. Dev.), minimum (Min.) and maximum (Max.). The groups of large firms (*LargeFirm*) and medium and small firms (*MSFirm*) are also considered separately in this analysis.

[Insert Table 2 around here]

We are able to identify 1185 bank-firm relationships, 303 with large firms and 882 with medium and small ones. By organizing the data in spells – where a spell represents the number of months a bank-firm relationship lasts and it is denoted by *Dur* – we can compute their mean duration. These relationships last on average around 111 months, but they last longer in the group of medium and small firms (about 114 months, on average) than in the group of large firms (around 105 months, on average). Whether there is any significant difference or not in the duration of bank-firm relationships between these two groups of firms is something that we will test below in the empirical analysis by including the dummy *LargeFirm* in the model. Moreover, some separate regressions for each of these groups will also be considered, without and with the additional variables.

5. Empirical Results

The empirical results from the estimation of the basic Weibull model and from its change-point version are presented in this section. Some robustness checks are also provided in the end of this section.

5.1. The baseline model

The empirical evidence from the estimation of the basic Weibull model presented in sub-Section 3.2 is shown in Tables 3 and 4. The regressions in Table 3 are oriented simply to control for duration dependence; in Table 4 are considered the additional regressors. We start this analysis noticing that the estimate of p measures the magnitude of the duration dependence and γ corresponds to the estimate of the constant term. A one-sided test is used to detect the presence of positive duration dependence (i.e. whether $p>1$) and the sign '+' indicates significance at a 5% level.

The results reported in Table 3 provide strong evidence of positive duration dependence for bank-firm relationships (p is statistically greater than 1). This means that the likelihood of a bank-firm relationship ending increases as the time goes by. This is valid not only for the basic regressions presented in column 1, but also for the following ones. Another interesting aspect to consider is the rate at which the respective likelihood evolves: p is in most of the cases statistically lower than 2, which means that the statistical analysis of the second-order derivative of the baseline hazard function indicates the presence of decreasing positive duration dependence. Putting it differently, the probability of bank-firm relationships ending at time t, given that they lasted until that moment, increase over time at a decreasing rate.[5]

[Insert Table 3 around here]

[5] See Castro (2010, 2013) for details on the analysis of the second-order derivative for the baseline hazard function.

We started by assuming that bank-firm relationships may have a length from one quarter to the maximum observable in our sample. However, their minimum duration is higher than one (it is six – see Table 2). Therefore, in our duration analysis it will be interesting to evaluate whether truncating at the minimum duration affects the results or not. This means that the hazard rate must be identically zero for the first months and some non-zero value thereafter. Truncation is made at the minimum observable durations: $d_0=min(d_i)-1$, where $\min(d_i)$ is the shortest duration observed in the sample (six, in our case). This means that the survival function is now:

$$S(t_i, \mathbf{x}_i) = \exp[-\gamma(t_i^p - d_0^p)\exp(\mathbf{x}_i\boldsymbol{\beta})] \tag{16}$$

Truncation is allowed for in the regression presented in Column 2 of Table 3, but the results are not affected by this "small" truncation: decreasing positive duration dependence is still present in bank-credit relationships. In general, results in this kind of studies have not shown sensitive to the choice of this minimum observable duration and the qualitative conclusions tend to be identical in any case.[6] Thus, we carry on with our analysis without taking into account this intricacy in the model.

In the regressions presented in column 1, we also assume that the population of individual spells is homogeneous, i.e. each relationship is under the same risk of ending. Supposing that this might not represent the reality, the regressions in column 3 allow for the presence of unobserved heterogeneity or frailty.[7] In order to include frailty in the Weibull model, the hazard function expressed in equation (3) is modified as follows:

$$h(t, \mathbf{x} \mid v) = v h(t, \mathbf{x}) \tag{17}$$

where v is an unobserved individual-spell effect that scales the no-frailty component. The random variable v is assumed to be positive with unity mean, finite variance (θ) and independently distributed from t and $\mathbf{x}$.

[6] See, for example, Sichel (1991), Layton and Smith (2007) and Castro (2010, 2013).

[7] In statistical terms, a frailty model is similar to a random-effects model for duration analysis: it represents an unobserved random proportionality factor that modifies the hazard function of an individual spell and accounts for heterogeneity caused by unmeasured covariates or measurement errors.

Since the values of v are not observed, we cannot estimate them. Therefore, we follow Lancaster (1990) and assume v follows a Gamma distribution with unity mean and variance θ. Consequently, the frailty hazard function becomes:

$$h(t,\mathbf{x}\,|\,\beta,\theta) = h(t,\mathbf{x})[S(t,\mathbf{x}\,|\,\beta,\theta)]^{\theta} \qquad (18)$$

where the frailty survival function is $S(t,\mathbf{x}\,|\,\beta,\theta) = [1-\theta \ln S(t,\mathbf{x})]^{-(1/\theta)}$.

Hence, the variance parameter (θ), which measures the presence (or absence) of unobserved heterogeneity, is an additional parameter that needs to be estimated.[8] The results show some evidence of unobserved heterogeneity: at a 5% level we do not reject the presence of frailty. This can be due to the omission of some relevant conditionings. According to Jenkins (2005, p. 81) omitted variables are one reason for the presence of frailty in the model. Hence, in the next regressions, especially in Table 4, we will control for that problem including some additional regressors in the equation.[9]

In particular, frailty might be linked to the presence of individual firm-specific effects in the model. However, Claessens et al. (2011, p.17) points out that having only a limited number of observations/spells per individual – which is our case: we have only one duration spell for each firm – fixed effects may have to be ruled out. However, a way of partially circumvent this limitation is to consider two sets of firms that are considered to present some homogeneity inside each group, but that are heterogeneous between then: large firms and small and medium firms. This procedure (partially) solves the problems faced with the use of individual-dummies – controlling for eventual individual or group

[8] As θ is always greater than zero, the limiting distribution of the maximum-likelihood estimate of θ is a normal distribution that is halved or chopped-off at the zero-bound. Therefore, the likelihood ratio test used to detect its presence is a `boundary' test that takes in account the fact that the null distribution is not the usual chi-squared with one degree of freedom, but rather a mixture of a chi-squared with no degrees of freedom and a chi-squared with one degree of freedom (Gutierrez et al., 2001).

[9] Furthermore, we should stress that when we tried to control for frailty with those additional regressors in the model we did not achieve convergence. Therefore, we had to proceed our analysis with the more parsimonious structure for the Weibull model.

heterogeneity – and allow us to test for differences in the mean duration of the bank-firm relationships between those two groups of countries.

Thus, in regression 4, we add the dummy variable *LargeFirm* to the model. As expected, the coefficient associated to this variable is positive, which provides an indication that, on average, bank-firm relationships are shorter when the firm is large.[10] This result is in line with what we have observed in the descriptive statistics, however, the coefficient on *LargeFirm* is not statistically significant. The separate regressions for large firms and medium and small firms presented in columns 5 and 6, respectively, point out in the same direction in what regards to the magnitude of the duration dependence parameter: both groups present evidence of decreasing positive duration dependence. In fact, the rate at which bank-firm relationships end in these groups of firms is slightly the same. However, the coefficient on the constant is (higher and) statistically significant only in the group of small and medium firms. This may indicate that some differences between these two groups might in fact exist and that they might be significant. In order to analyse that issue in greater detail, we proceed the analysis including some additional conditionings in the model.

In Table 4 are shown the results from the Weibull model with additional regressors. Despite the inclusion of those covariates, positive duration dependence is still characterising the bank-firm relationships. However, the magnitude of the parameter p has increased: constant or increasing positive duration dependence is now observed. This is not a surprising result because, as Jenkins (2005) notices, when relevant regressors are not included in the model the duration dependence parameter tends to be downward biased.

The first group of regressors to be included in the model relates to the firms characteristics (see column 1). The results indicate that only the coefficients on *LargeFirm*, *FirmAge*, *LnTurn* and *LnProfit* are statistically significant and confirm the findings of Ongena and Smith (2001a). Indeed, by controlling for some additional characteristics, we

[10] Note that a positive coefficient means a higher probability of an event ending over time, i.e. a shorter duration; a negative coefficient means the opposite.

are able to find significant evidence that, on average, bank-firm relationships are shorter when a firm is large. This result is consistent with what we expected given that banks mainly used transactions technologies to deal with large firms instead of relationship lending technology (e.g. Berger and Udell, 2002; Berger and Udell, 2006). This proves that the observed difference in the mean duration of bank-firm relationships, between large, medium and small firms observed in the descriptive statistics, is indeed statistically significant.

Furthermore, both, the older firms and the firms with higher turnovers and profits tend to form stronger and longer lasting bonds with the bank. Thus, it seems that those less risky firms benefit from better pricing conditions than those which are younger and smaller, and hence suffer less from the information monopoly of bank. Indeed, the small and relatively recent firms are credit constrained as a result of their opacity (Petersen and Rajan, 1995, Sakai et al., 2010). This also might be the consequence of the mutual interest of the bank and of these firms in maintaining their relationship, provided the benefits they can obtain from each other. Regarding the sector in which they are operating and the probability of default, no relevant results are found. Furthermore, our proxy of the firm's transparency (*Transparency*) does not seem to play a significant role on the duration of these relationships. It is possible that other variables such as firm's age, size, turnover and profit capture this effect.

[Insert Table 4 around here]

When specific characteristics of the bank are considered in the model (regression 2, in Table 4), we observe that the coefficients on the market share and Lerner index are statistically significant, both with a positive sign.[11] Hence, the higher the local bank's market power and the higher the Lerner index (i.e. the lower the banking competition), the

[11] We also tried to include the square of these variables in the model, but the respective coefficients have not proved to be statistically significant. The results are not reported here to save space, but they are available upon request.

higher the likelihood of the bank-firm relationship breakdown will be. Our results are consistent with the empirical outcomes of Elsas (2005) regarding the effect of bank market power on the relationship lending. We support the theoretical prediction that higher market power allows the bank to extract rents from lending over the duration of the relationship – the "hold-up problem" – (Sharpe, 1990; Rajan, 1992). So, the solution for firms to avoid this “informational capture” is to make the relationship shorter (Rajan, 1992). According to our results, poorer banking competition works in the same direction, which supports the outcomes of Degryse and Ongena (2007).

As for the pricing conditions or, more specifically, for bank’s earnings from its relationships, no relevant effects are found for the aggregate variable *BankIncome*, but interesting findings are provided for its components in accordance with our predictions. On one hand, short-term credit and savings revenues are, as expected, negatively linked to the likelihood of a relationship ending. In fact, they tend to last longer because intensive credit and saving activities between the bank and the firm promotes the collection of information which enhances the tie between them. On the other hand, higher bank’s revenues from arm’s length services sales to firms contribute to shorter relationships given that its low contribution to the collection of private information.

We should also notice that the other results are not affected by the inclusion of these bank-specific variables, with the exception of *DefaultProb* which has know a statistically significant coefficient, showing that it has a negative impact on the likelihood of a relationship ending. In fact, it seems that when the probability of default increases, firms tend to become more dependent on the bank. Indeed, risky firms face more difficulties to find another source of funding, which increases their reliance on existing lending relationship. Therefore, these firms are more prone to informational monopoly and to the “hold-up” problem and accept to undergo very strict pricing conditions which fit the bank’s convenience (Rajan, 1992; Santos and Winton; 2008).

As for the control variables on the bank-firm relationship, the number of bank's relationships has shown no impact on the duration of relationships (see column 4), which contrasts with the findings of Ongena and Smith (2001a). Nonetheless, our findings confirm those of Elsas (2005) and show that the number of firms' creditors does not influence the duration of the relationship between the bank and firms.

We also find that when the bank's share of total firm indebtedness is higher, the bank-firm relationship tends to last longer. As expected, a higher share of banking loan supplied to the firm indicates that the business bonds between the bank and the firm are stronger and deeper, and allows for more acquisition of valuable information which enhances the tie between the borrower and the lender. Therefore, consistent with Elsas (2005), we find that bank's share of total debt financing of a firm is an important conditioning element of the bank-firm relationship.

The distance variable presents a positive effect on the likelihood of the bank-firm relationships ending, but its coefficient has not proved to be statistically significant. This means that the location of the firm is not as relevant to the duration of the relationship as sustained by Hauswald and Marquez (2006) trough the informational channel theory or by Sussman and Zeira (1995) via the transactional costs channel theory.

Additionally, we also control for the information that the bank gathers about their costumers and concluded that only the "soft" information – i.e. the loan officer's assessment of the firm's quality – is relevant to explain the duration of the relationship: as expected, a better assessment contributes to a stronger and longer relationship. We also note that the other results were not affect with the inclusion of these bank-firm relationship variables.

Finally, in the regression 5, we also control for the business climate. As expected, we observe a positive relation with the likelihood of a bank-firm relationship ending. However, the coefficient on this variable is not statistically significant. In an additional regression not reported here, we also tried to collect this effect using a broader (dummy) variable for the periods of recession in France, but it has not proved to be relevant either.[12] This means that the economic environment is not detrimental to the duration of such particular relationships. Other specific characteristics to the firms, to the bank and to their relationships, as well as their duration, are much more important to justify the length of those relationships.

In regression 6, we only include those variables that have significant coefficients in the previous regressions. The results are consistent with what we have described so far, therefore, this has been used as a benchmark model for the remaining part of this study. In columns 6 and 7 we present the results for the groups of large firms and medium and small firms, respectively. They confirm the presence of positive duration dependence in both groups of the firms (constant in the first group and increasing in the second), however, some differences are noticed regarding the other control variables.

Regarding the firms' characteristics, we observe that the age of the firm is relevant for both groups. However, the turnover, profitability and default probability only influences the duration of bank's relationship with small and medium firms; these variables are no longer relevant when large firms are taken into account. These results are consistent with our previous findings and confirm that small-and medium-sized enterprises (SME) are more likely to undergo "informational capture" by the lender and therefore rely more on the relationship technology. Additionally, bank-specific characteristics have proved to influence small and medium firms' relationships significantly and in the same direction as the one identified for all firms in the previous regressions. However, large firms' relationships only tend to last longer when banking competition is not very intense and bank rents from credit and saving operations are higher. Moreover, the bank-firm relationship variables are not relevant when the analysis considers those large firms. For medium and small firms we confirm the increase in the length of bank-firm relationships when *FinShare* is higher and *SoftInfo* improves.

[12] The respective results are available upon request.

5.2. The model with change-points in duration dependence

The results presented in Tables 3 and 4 rely on the assumption that the magnitude of the duration dependence parameter is invariant whatever the duration of the bank-firm relationships. In Figures 1 to 3, we plot the survivor functions for those relationships for all firms (Figure 1), large firms (Figure 2) and medium and small firms (Figure 3). It can be seen that the probability (or proportion) of a relationship surviving after duration t_i substantially decreases as they become older. This sharp decline is consistent with the existence of positive duration dependence. Moreover, the survivor functions in the three groups quick fall until t_i=273 (about 23 years) but, then, evolve at a much slower pace. This highlights the possibility of breaks in duration dependence and the need of a more flexible framework allowing for change-points in the Weibull distribution at τ_c=273. In fact, Figures 1 to 3 suggest that the magnitude of duration dependence parameter might be lower when relationships are longer than this value and the likelihood of they ending can significantly change above that threshold. Thus, there is evidence to suspect that change-points in the duration of bank-firm relationships may indeed exist.

[Insert Figure 1 around here]

[Insert Figure 2 around here]

[Insert Figure 3 around here]

In order to test for the presence of differences in the duration dependence parameter, we consider a Weibull model with a change-point. Hence, we estimate two dependence duration parameters, one for the first duration-period (p_1) and another one for the second duration-period (p_2), and evaluate the statistical significance of the difference between the two (p_2-p_1).[13,14] The results are reported in Table 5.

In column 1, we estimate a simple equation without covariates considering all the firms in the dataset; then, columns 2 and 3 present the results for the groups of large firms

[13] The estimates for the two constant terms are $\gamma_1=\lambda_1^{p_1}$ and $\gamma_2=\lambda_2^{p_2}$.

[14] The delta method is used to compute the respective standard-errors.

and medium and small firms, respectively. In regressions 4 to 6, we provide the results for the same sets of firms, but controlling for the most relevant regressors.

[Insert Table 5 around here]

As expected, the results presented in Table 5 show that the duration dependence parameter indeed varies with the duration of the bank-firm relationships. In particular, the magnitude of the duration dependence parameter is always significantly lower when those relationships are longer than about 23 years (273 months), in either group of firms and with or without the additional regressors in the model. Note also that the difference between the parameters after and before the respective change-point (p_2-p_1) is always negative and statistically significant (except in the group of large firms).[15] In particular, considering the model without additional regressors, (decreasing or constant) positive duration dependence is observed in those relationships that last less than 273 months, while negative duration dependence characterizes the relationships that last more than that threshold (except for the group of large firms, where no duration dependence is found after that change-point). This means that those relations become stronger when they last more than 23 years as the likelihood of them ending indeed starts to decrease after that moment onwards.

When the additional regressors are included in the model, increasing positive duration dependence is observed in all regressions for relationships that last less than 23 years, but when they last more than that threshold duration dependence is no longer present, i.e. the likelihood of them ending is no longer dependent on their age. Indeed, while the parameter p_1 is statistically significant in all specifications, p_2 does not exhibit statistical significance in any of the groups considered in our analysis. Moreover, the difference

[15] Even though Figures 1 to 3 are clear about the location of the change-points, we tried other months as change-points, but unsurprisingly this difference was never statistically significant in those cases. Some of those experiments are reported below in the robustness checks; additional experiments are available upon request.

between the two parameters remains statistically significant. Hence, we have evidence to argue that there is a change-point in the duration of bank-firm relationships.

After controlling for change-points, we are still observing that the average duration of the bank-firm relationships is significantly higher in the group of medium and small firms. Regarding the other regressors, the results confirm that those relationships last longer: (*i*) when firms are older, have a higher turnover and profitability and when the default probability is higher; (ii) when the bank's market power is lower and the level of banking competition in higher; (iii) when pricing conditions are favourable (higher rents from credits and savings and lower revenues from arm's length sales); (iv) and when the bank's share of total firm's banking debt is higher and the bank's assessment on firm's quality improves.

Thus, our results allow us to conclude that there is strong evidence supporting the presence of a change-point in the duration of bank-firm relationships, independently of the sub-group of firms considered, with or without additional regressors in the model. This represents a striking finding in this field of the literature that certainly contributes to a better understanding of the bank-firm relationships.

5.3. Robustness checks

When we look at the figures for the survival functions, we are able to identify two spells that last more than 1000 months, while the others last less than 600 months (all firms and medium-small firms). As these two observations can be considered outliers and might influence the results, we decided to exclude them from the sample and check whether our conclusions are affected or not. The results are presented in Table 6 (columns 1-4). The regressions only consider the cases where the outliers are identified: all firms and medium-small firms. In the first two regressions, we do not control for the presence of a change-point; it is controlled for in regressions 3 and 4. The results and conclusions of this study are not affected by the exclusion of those two outliers. In particular, increasing positive duration dependence is found for those relationships that last less than 23 years, but they are no longer duration dependence when they last more than that threshold; Moreover, the results and conclusions obtained so far regarding the firms and bank's variables, the pricing conditions and the bank-firm relationship variables remain essentially the same.

[Insert Table 6 around here]

Even though Figures 1 to 3 present a clear indication about the location of the change-points, we tried other months as change-points. The results from one of those experiments are presented in the last three columns in Table 6, for all, large, and medium and small firms. The change-points considered here are, respectively, 225, 175 and 225 months. Although positive duration dependence is found in the first period and no duration dependence is observed in the second period, the difference is not statistically significant in either case. Hence, we cannot consider those threshold values as change-points. Nonetheless, the other results and conclusions remain unchanged.

6. Conclusions

This paper analyses whether bank-firm relationships are duration dependent and investigates the presence of change-points in their likelihood of ending. These represent important avenues of research that have not been explored in the literature yet. As a way of filling that gap, we employ a duration model over a group of 1185 bank-firm relationships to investigate whether the likelihood of ending depends indeed on its own age and to check the presence of change-points in its behaviour. For each relationship spell we also control for information on the firm-level characteristics, bank market power, pricing conditions, on their specific individual bank-borrower relationship variables and on the economic environment.

The data set used in this study, unlike previous empirical works, is much more comprehensive and is particularly adequate to analyse lending relationships given that it concern only to firms considered opaque and subject to severe informational asymmetries.

Further, our database considers only the French credit market, one of the majors in the EU economy.

First of all, the findings of the baseline Weibull duration model applied to this study are consistent with those of Ongena and Smith (2001a) and show the presence of positive duration dependence in the bank-firm relationships, which implies that their likelihood of ending increases over their duration. However, these results are not in line with the theoretical framework of lender-firm relationship which predicts “informational capture” of borrowers in bank-firm relationships over time, in the asymmetric information context (Sharpe, 1990; von Thadden, 2004). Consistently with the results provided by Ongena and Smith’s (2001a), our empirical analysis finds that the relationship duration of small, young, and less profitable firms is shorter.

Our study is of particular interest, as it is the first to extend the baseline Weibull duration model in order to allow for breaks or change-points in the duration dependence parameter of lending relationships. While the basic Weibull model assumes that the behaviour of duration dependence is smooth (i.e. either constant, increasing or decreasing) over time, the degree of likelihood of a relationship ending as it gets older may change after a given duration. The empirical findings indeed support the presence of a change-point: (increasing) positive duration dependence is observed in relationships that last less than 23 years, but then it becomes non-relevant (or even negative) for longer events. A possible interpretation of our results is that the probability to terminate the firm-lender relationship by small-and medium-sized enterprises (SME) increases with time, as a consequence of the rising risk of being “informationally captured” and of the increasing switching costs faced over time (von Thadden, 2004). However, when firms are totally locked-in to informed lenders and their switching costs are so high that firm can no longer change banks, the likelihood to end the bank-firm relationship decreases (Sharpe, 1990). In our sample, this happens after 23 years of bank-firm relationship. This represents an important empirical finding in this field of the literature and certainly contributes to a better and deeper understanding of the bank-firm relationships.

The outcomes provided by this study also indicate that bank-firm relationships are, on average, longer when medium and small firms are involved in the relationship, when firms are older, have a higher turnover and profitability and when the default probability is higher. A similar behaviour is found when the bank's market power is lower and the level of banking competition is higher. However, the market power of the bank loses its influence when only large firms are considered in regressions, which may be explained by their greater bargaining power (Grunert and Norden; 2012) and their low exposure to the informational rent "hold up problem". The pricing conditions have also proved to be important for bank-firms relations: higher rents from credits and savings and lower revenues from arm's length sales tend to promote longer relationships.

Additionally, our study shows that some specific bank-firm relationship variables, related to the gathering of individual private information by the bank, also play an important role in their duration. Our findings point out that those relationships last longer when the bank's share of total firm's banking debt is higher and the bank's assessment on firm's quality ("soft" information) improves, which is somehow in line with the work by Elsas (2005). Nevertheless, the number of relations and physical distance between the firm and the bank has not proved to affect the probability for the bank-firms relationships to terminate. Hence, the theoretical and empirical findings provided by Hauswald and Marquez (2006) and Agarwal and Hauswald (2010) on this matter are not observed in this particular case-study. We also analyse the impact of the economic conditions on the length of those relationships, but no significant influence was found on their duration.

While providing valuable information on the duration of bank-firm relationships, the present paper opens new avenues for future work. For instance, given that the selection of the change-point is exogenously determined by a sensible graphical analysis of the survivor function, an interesting extension of this piece of research would be to incorporate a discrete latent variable in the standard Weibull model. This would make the selection of the change-point endogenous, thereby, representing a challenging and promising approach to be considered in the future.

Another possible extension is related to the dataset. Considering other banks in the sample and their relations with their corporate customers will enrich the analysis and provide further information regarding the bank-firm relationships and the banks' competition. However, it is not easy to get that information and some comparative issues may take difficult that analysis. Nevertheless, this is another interesting extension to be considered in future research.

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Appendix A:

To compute the Lerner index of the bank, we first estimate the following translog cost function using a single output (Total assets), three input factors (the fund costs, capital costs and labor cost) and three netputs (fixed assets, provisions for "bad" debts and capital) using data of 235 French banks over 1999-2012:

$$\begin{aligned} Ln\,TC_{it} = {} & \alpha_i + \beta_1 lnQ_{it} + \frac{\beta_2}{2} lnQ_{it}^2 + \sum_{K=1}^{2} \gamma_k lnW_{K,it} + \sum_{K=1}^{2} \varphi_k lnZ_{K,it} \\ & + \frac{1}{2}\sum_{K=1}^{2}\sum_{j=1}^{2} \theta_{kj}\, lnW_{K,it}\, lnW_{j,it} + \frac{1}{2}\sum_{K=1}^{2}\sum_{j=1}^{2} \omega_{kj}\, lnZ_{K,it}\, lnZ_{j,it} \\ & + \frac{1}{2}\sum_{k=1}^{2} \emptyset_k\, lnQ_{it}\, lnW_{k,it} + \frac{1}{2}\sum_{k=1}^{2} \partial_k\, lnQ_{it}\, lnZ_{k,it} \\ & + \frac{1}{2}\sum_{K=1}^{2}\sum_{j=1}^{2} \epsilon_{kj}\, lnW_{K,it}\, lnZ_{j,it} + ln\mu_{it} + ln\varepsilon_{it} \end{aligned} \tag{19}$$

Where TC denoted the bank total costs which are a function of outputs (Q), estimated by the total assets. W is the vector of inputs (the funds cost (W_1), capital cost (W_2) and labor cost (W_3)), and netputs are represented by the vector Z (fixed assets, *(Z1)* provisions for "bad" debts, (Z_2), and equity capital (Z_3)). Standard homogeneity conditions are imposed by scaling all total costs and inputs factors by the labor price and the heterogeneity are corrected by dividing by equity capital (Z_3). We obtained the marginal costs using the estimated parameters of the translog function by calculating the derivative with respect to total assets (Q) as follows:

$$MC_{it} = \frac{\partial\, TC}{\partial\, Q} = \frac{TC_{it}}{Q} \left[\beta_1 + \beta_2 lnQ_{it} + \sum_{k=1}^{3} \emptyset_k\, lnW_{k,it}\right] \tag{20}$$

We use the stochastic frontier approach (SFA) to estimate the translog function (Koetter et *al.*, 2012). We also add years dummy to consider the effects of technical change on costs over time.

List of Tables

Table 1. Description of the variables, expected signs and sources

Variables	Description	Signs
Dur	Duration of the Bank-Firm relationship, in months.	
LargeFirm	Dummy variable that takes value 1 when the firm is large (with mode than 250 employees); 0, otherwise (medium and small firms).	+
FirmAge	Age of the firm, in years.	– / +
Trade	Dummy variable that takes value 1 when the firm is operating in the commerce sector; 0, otherwise.	– / +
Indus	Dummy variable that takes value 1 when the firm is operating in the industrial sector; 0, otherwise.	– / +
Serv	Dummy variable that takes value 1 when the firm is operating in the services sector; 0, otherwise.	– / +
Constr	Dummy variable that takes value 1 when the firm is operating in the construction sector; 0, otherwise.	– / +
AAI	Dummy variable that takes value 1 when the firm is operating in the agriculture or agri-food industry sector; 0, otherwise.	– / +
LnTurn	Logarithm of the firm's turnover (thousands of euros).	–
LnProfit	Logarithm of the firm's profitability, i.e. the log of the EBITDA over the net value of total assets (both in thousands of euros); this ratio was truncated to zero when negative.	–
DefaultProb	Default probability (the result of bank's internal rating taking into account soft and hard information for the firm).	– / +
Transparency	Proxy of firms' transparency, dummy variable that takes value 1 when the legal status of the company requires a board of directors and a periodic publication of audited financial statements; 0, otherwise.	+
MktShare	Bank's market share of corporate loans (in percentage), i.e. market power of bank in the geographical location of the firm.	– / +
LernerIndex	The Lerner index to control for the level of banking competition (in percentage).	– / +
BankIncome	Net banking income or rent, i.e. the total amount of the whole relationships earnings for the bank during the last 12 months (in thousands of euros), which is computed as follows: Net banking income = NBI_Credit_MLT + NBI_Credit_ST + NBI_Saving + Arm's Length_NBI where:	– / +
	- NBI_Credit_MLT (*BkIncCrdMLT*) is the amount of the bank's revenue from medium and long-term credit activities with the firms during the last 12 months.	–
	- NBI_Credit_ST (*BkIncCrdST*) is the amount of the bank's revenue from short-term credit activities with the firms during the last 12 months.	–
	- NBI_Saving (*BkIncSaving*) is the amount of the bank's revenue from the saving relationship activities with the firms during the last12 months.	–
	- Arm's Length_NBI (*BkIncArm*) is the amount of the bank's revenue from arm's length services sale to SME during the last 12 months.	+
Relations	Dummy variable that takes value 1 when the number of the firms' bank relationships is greater than 1 (multibancarity); 0, otherwise (exclusivity).	+
FinShare	Bank's share of the total firm's banking debt from (0-1 scale).	–
Distance	Dummy variable that takes value 1 when the headquarters of the firm is not in the same location of the loan officer's branch of the bank; 0, otherwise.	+
SoftInfo	Loan officer's assessment of non-financial firm's quality expressed on a score from 0 (the worst) to 20 (the best).	–
HardInfo	An internal credit scoring based on audited financial statements, scaled from 0 (the worst) to 20 (the best).	+
BusClimate	Business climate obtained from French monthly business sentiments index regarding different business sectors.	+

Sources: The definitions of the variables presented in this table relate to a sample of 1185 individual bank-borrower relationships for the period 2008-2013. These are the firms in the loan officer's credit reports of the bank from which we collect data. The loan officer's credit report is the loan officer annual assessment of firm's credit worthiness. The credit reports contain information about the duration of relationship (*Dur*), the kind of relationship (*Relations),* firms' default probability (*DefaultProb),* the net banking income and its different components (*BankIncome, BkIncCrdMLT, BkIncCrdST, BKIncSaving, BKIncArm*), the loan officer's assessment of firm's quality (*SoftInfo*), the outcome of internal credit scoring system based on financial informations (*HardInfo*) the location of company headquarters (*Distance),* the share of the total firm's banking debt at the date of assessment (*FinShare),* the firms' sector of activity (*Trade, Indus, Serv, Constr, AAI).* Data on the bank's market share of corporate loans in the geographical location of the firm's (*MktShare)* was gathered from the bank, this information is quarterly data provided by the French Central Bank to each bank granting credit at the level of French department (geographical location). Data on the business climate (*BusClimate)* are computed by France's National Institute of Statistics and Economic Studies (INSEE). We use DIANE database for *FirmAge, LnTurn, LNProfit, LargeFirm and Transparency*, a dataset about French firms to access information on firm's specific characteristics and firm's balance sheets data. We use the SIREN number (a nine-figure identifier attributed to each firm by France's National Institute of Statistics and Economic Studies) to identify each firm. *LernerIndex* is the result of our calculation using Bankscope database.

Table 2. Descriptive statistics

Variables	**No. Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Dur	1185	111.2	90.35	6	1366
Dur if LargeFirm	*303*	*104.6*	*66.28*	*15*	*532*
Dur if MSFirm	*882*	*113.5*	*97.18*	*6*	*1366*
LargeFirm	1185	0.256	0.436	0	1
FirmAge	1185	24.00	21.18	1.770	113.2
Trade	1185	0.254	0.435	0	1
Indus	1185	0.159	0.366	0	1
Serv	1185	0.418	0.493	0	1
Constr	1185	0.098	0.297	0	1
AAI	1185	0.053	0.224	0	1
LnTurn	1107	7.947	1.984	-1.609	14.52
LnProfit	1185	4.910	7.135	0	59.49
DefaultProb	1133	0.074	0.206	0	1
Transparency	1181	0.122	0.327	0	1
MktShare (%)	1185	41.47	0.774	40.56	44.79
LernerIndex (%)	1071	25.04	1.857	22.53	29.46
BankIncome	1185	7.306	15.87	-28.78	274.5
BkIncCrdMLT	1185	1.459	7.517	-31.39	149.0
BkIncCrdST	1185	1.263	9.737	-6.938	229.3
BkIncSaving	1185	0.760	2.445	0.000	51.89
BkIncArm	1185	3.824	6.654	0.011	114.9
Relations	1185	0.892	0.311	0	1
FinShare	1185	0.322	0.375	0	1
Distance	1185	0.258	0.438	0	1
SoftInfo	1185	10.58	3.351	0	20.00
HardInfo	1185	10.41	4.131	0	19.55
BusClimate	1185	90.56	5.597	71	109

Notes: See Table1. This table reports the number of relationships (No. Obs.), their mean duration (Mean), the respective standard-deviation (Std. Dev.), and the minimum (Min.) and maximum (Max.) duration of those relationships.

Table 3. Basic Weibull model regressions

	(1)	(2)	(3)	(4)	(5)	(6)
γ	0.00007**	0.00009**	0.00005**	0.00007**	0.00005	0.00007**
	(0.00003)	(0.00004)	(0.00003)	(0.00003)	(0.0004)	(0.00004)
p	$1.449^{+,d}$	$1.413^{+,d}$	$2.183^{+,c}$	$1.458^{+,d}$	$1.548^{+,d}$	$1.436^{+,d}$
	(0.089)	(0.095)	(0.188)	(0.088)	(0.150)	(0.100)
θ			3.955***			
			(0.244)			
LargeFirm				0.198		
				(0.245)		
LogL	-337.4	-748.7	-305.8	-337.0	-88.7	-248.2
AIC	678.7	1501.5	627.6	680.1	181.4	500.5
SBIC	688.9	1511.6	632.8	695.3	188.8	510.1
Observ.	1185	1185	1185	1185	303	882
Censored	92	92	92	92	24	68

Notes: For sources, see Table 1. Robust standard errors clustered by firm for the estimated coefficients are in parentheses. Significance level at which the null hypothesis is rejected: ***, 1%; **, 5%; and *, 10%. The sign "+" indicates that *p* is significantly higher than 1 using a 5% one-sided test with robust standard errors; *d*, *c* and *i* indicate the presence of decreasing, constant or increasing positive duration dependence, respectively, at a 5% level. AIC=2[-LogL+k] and SBIC=2[-LogL+(k/2)Log$N$], where LogL is the log-likelihood for the estimated model, k is the number of regressors and N is the number of observations. LRI is the likelihood ration index or pseudo-R^2 (LRI=1-LogL/LogL_0, where L_0 is the likelihood of the model with only a constant term). "Censored" indicates de number of censored observations. Column (1) presents the results of a continuous-time basic Weibull model; truncation at the minimum value of *Dur* (6 months) is used in regression (2); in regression (3), frailty is controlled for; columns (5) and (6) present results for the group of 'large' firms and 'medium and small' firms, respectively.

Table 4. Weibull model regressions with additional regressors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
γ	0.0005	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
	(0.0005)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
p	$1.768^{+,c}$	$2.180^{+,c}$	$2.410^{+,i}$	$2.698^{+,i}$	$2.693^{+,i}$	$2.549^{+,i}$	$2.389^{+,c}$	$2.760^{+,i}$
	(0.147)	(0.180)	(0.213)	(0.224)	(0.222)	(0.195)	(0.293)	(0.272)
LargeFirm	0.510*	1.171***	1.097***	0.771**	0.756**	0.614**		
	(0.302)	(0.323)	(0.312)	(0.322)	(0.321)	(0.313)		
FirmAge	-0.060***	-0.048**	-0.056**	-0.051**	-0.051**	-0.056***	-0.051*	-0.063**
	(0.020)	(0.020)	(0.022)	(0.020)	(0.020)	(0.021)	(0.029)	(0.027)
Trade	-0.125	1.472*	1.261	1.341	1.345			
	(0.625)	(0.858)	(0.923)	(0.967)	(0.974)			
Indus	0.161	0.844	0.561	0.435	0.476			
	(0.657)	(0.845)	(0.884)	(0.921)	(0.939)			
Serv	-0.500	0.651	0.570	0.506	0.519			
	(0.607)	(0.795)	(0.863)	(0.926)	(0.935)			
Constr	0.270	1.257	0.935	0.960	0.962			
	(0.669)	(0.854)	(0.888)	(0.900)	(0.907)			
LnTurn	-0.234***	-0.222***	-0.161*	-0.263***	-0.265***	-0.195**	-0.099	-0.258***
	(0.072)	(0.083)	(0.084)	(0.084)	(0.084)	(0.077)	(0.151)	(0.074)
LnProfit	-0.303***	-0.237***	-0.237***	-0.181**	-0.181**	-0.215**	-0.294	-0.254*
	(0.092)	(0.069)	(0.079)	(0.083)	(0.084)	(0.090)	(0.219)	(0.136)
DefaultProb	-0.448	-1.288**	-1.502**	-1.946**	-1.934**	-1.903**	1.317	-2.195**
	(0.617)	(0.632)	(0.722)	(0.788)	(0.789)	(0.792)	(1.776)	(0.914)
Transparency	0.256	-0.085	-0.136	-0.035	-0.032			
	(0.463)	(0.423)	(0.458)	(0.417)	(0.419)			
MktShare		0.548***	0.656***	0.640***	0.673***	0.558***	0.097	0.674***
		(0.147)	(0.169)	(0.157)	(0.184)	(0.139)	(0.311)	(0.164)
LernerIndex		0.554***	0.527***	0.484***	0.400*	0.454***	0.455***	0.485***
		(0.101)	(0.101)	(0.105)	(0.215)	(0.087)	(0.162)	(0.115)
BankIncome		-0.015						
		(0.011)						
BkIncCrdMLT			-0.030	0.017	0.018			
			(0.061)	(0.026)	(0.026)			
BkIncCrdST			-0.448***	-0.487***	-0.482***	-0.543***	-0.183*	-0.742***
			(0.120)	(0.121)	(0.121)	(0.119)	(0.101)	(0.203)
BkIncSaving			-0.858**	-0.846**	-0.824**	-0.749**	-0.688*	-0.459*
			(0.394)	(0.401)	(0.409)	(0.380)	(0.354)	(0.255)
BkIncArm			0.035***	0.031***	0.030***	0.027***	-0.012	0.028***
			(0.010)	(0.010)	(0.010)	(0.010)	(0.062)	(0.010)
Relations				-0.174	-0.184			
				(0.454)	(0.456)			
FinShare				-1.800**	-1.797**	-1.526**	-2.257	-1.441**
				(0.700)	(0.707)	(0.603)	(1.494)	(0.735)
Distance				0.310	0.294			
				(0.324)	(0.332)			
SoftInfo				-0.059*	-0.059*	-0.075**	0.003	-0.091**
				(0.032)	(0.032)	(0.030)	(0.053)	(0.037)
HardInfo				-0.019	-0.021			
				(0.041)	(0.041)			
BusClimate					0.021			
					(0.054)			
LogL	-203.3	-135.5	-123.9	-111.8	-111.8	-116.5	-29.9	-79.0
AIC	430.6	301.0	283.8	269.7	271.6	261.0	85.8	184.0
SBIC	490.1	373.8	371.3	381.4	388.2	329.0	129.8	243.8
LRI	0.198	0.433	0.482	0.532	0.533	0.513	0.539	0.543
Observ.	1056	952	952	952	952	953	218	735
Censored	63	60	60	60	60	60	17	43

Notes: See Table 1 and Table 3. Columns (7) and (8) present separate results for the group of 'large' firms and 'medium and small' firms, respectively.

Table 5. Weibull model regressions with a change-point

	(1)	(2)	(3)	(4)	(5)	(6)
γ_1	0.0019***	0.0018***	0.0020***	0.0368***	0.0051***	0.3520**
	(0.0002)	(0.0003)	(0.0002)	(0.0051)	(0.0168)	(0.1504)
γ_2	0.0001	0.0012	0.00001	0.2292	0.0064***	0.7273
	(0.0002)	(0.0010)	(0.00006)	(0.6407)	(0.0025)	(3.8252)
p_1	$1.753^{+,d}$	$1.613^{+,d}$	$1.805^{+,c}$	$2.633^{+,i}$	$2.808^{+,c}$	$2.862^{+,i}$
	(0.085)	(0.149)	(0.101)	(0.200)	(0.529)	(0.289)
p_2	0.308^{-}	0.994	0.189^{-}	1.469	1.306	1.721
	(0.194)	(0.773)	(0.176)	(0.919)	(0.716)	(1.031)
p_2-p_1	-1.445***	-0.619	-1.616***	-1.164**	1.025	-1.141*
	(0.216)	(0.789)	(0.209)	(0.529)	(0.719)	(0.586)
LargeFirm				0.585*		
				(0.318)		
FirmAge				-0.056***	-0.056*	-0.063**
				(0.022)	(0.032)	(0.028)
LnTurn				-0.187**	-0.163	-0.250***
				(0.079)	(0.175)	(0.076)
LnProfit				-0.223**	-0.171*	-0.263*
				(0.092)	(0.092)	(0.136)
DefaultProb				-1.916**		-2.222**
				(0.804)		(0.937)
MktShare				0.544***	0.150	0.655***
				(0.141)	(0.266)	(0.165)
LernerIndex				0.441***	0.484***	0.467***
				(0.087)	(0.162)	(0.113)
BkIncCrdST				-0.527***	-0.282*	-0.735***
				(0.120)	(0.155)	(0.203)
BkIncSaving				-0.749**	-0.744*	-0.470*
				(0.374)	(0.408)	(0.251)
BkIncArm				0.027***	0.020*	0.028***
				(0.010)	(0.107)	(0.010)
FinShare				-1.472**	-2.144	-1.393*
				(0.587)	(1.320)	(0.716)
SoftInfo				-0.073**	-0.007	-0.088**
				(0.031)	(0.050)	(0.038)
LogL	-740.3	-193.1	-546.2	-379.7	-125.2	-269.8
AIC	1486.6	392.2	1098.5	791.4	278.5	569.6
SBIC	1501.8	403.3	1112.8	869.2	327.0	638.6
Observ.	1185	303	882	953	236	735
Censored	92	24	68	60	18	43

Notes: See Table 1 and Table 3. A change-point at duration 273 is tested in all regressions. The symbol "–" means negative duration dependence. Columns (5) and (6) present separate results for the group of 'large' firms and 'medium and small' firms, respectively.

Table 6. Robustness checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
γ_1	0.00001	0.00001	0.0369***	0.3521**	0.0284***	0.0484	0.0309
	(0.00001)	(0.00001)	(0.0050)	(0.1502)	(0.0023)	(0.2262)	(0.0841)
γ_2			0.2294	0.7272	0.0367*	0.0177	0.0367
			(0.6403)	(3.8250)	(0.0223)	(0.0416)	(0.1162)
p_1	2.611$^{+,i}$	2.846$^{+,i}$	2.633$^{+,i}$	2.863$^{+,i}$	2.591$^{+,i}$	2.775$^{+,c}$	2.798$^{+,i}$
	(0.203)	(0.293)	(0.200)	(0.290)	(0.198)	(0.537)	(0.285)
p_2			1.470	1.724	2.278$^{+,c}$	2.237$^{+,c}$	2.570$^{+,c}$
			(0.926)	(1.029)	(0.608)	(0.881)	(0.667)
p_2-p_1			-1.163**	-1.139*	-0.312	-0.538	-0.227
			(0.528)	(0.587)	(0.624)	(0.801)	(0.694)
LargeFirm	0.597*		0.586*		0.599*		
	(0.316)		(0.318)		(0.318)		
FirmAge	-0.058***	-0.067**	-0.057***	-0.065**	-0.056***	-0.050*	-0.063**
	(0.022)	(0.028)	(0.022)	(0.029)	(0.021)	(0.028)	(0.027)
LnTurn	-0.185**	-0.245***	-0.184**	-0.246***	-0.192**	-0.099	-0.255***
	(0.080)	(0.076)	(0.080)	(0.076)	(0.078)	(0.149)	(0.074)
LnProfit	-0.222**	-0.262**	-0.224**	-0.263**	-0.218**	-0.325	-0.256*
	(0.091)	(0.134)	(0.092)	(0.134)	(0.091)	(0.264)	(0.136)
DefaultProb	-1.928**	-2.240**	-1.922**	-2.235**	-1.916**	-1.393	-2.205**
	(0.807)	(0.937)	(0.806)	(0.939)	(0.798)	(1.933)	(0.925)
MktShare	0.553***	0.664***	0.546***	0.658***	0.551***	0.096	0.667***
	(0.137)	(0.161)	(0.140)	(0.164)	(0.140)	(0.323)	(0.165)
LernerIndex	0.441***	0.467***	0.439***	0.464***	0.449***	0.470***	0.480***
	(0.087)	(0.112)	(0.087)	(0.113)	(0.088)	(0.171)	(0.118)
BkIncCrdST	-0.537***	-0.744***	-0.529***	-0.739***	-0.536***	-0.190*	-0.741***
	(0.119)	(0.202)	(0.121)	(0.203)	(0.121)	(0.107)	(0.203)
BkIncSaving	-0.743**	-0.472*	-0.745**	-0.473*	-0.747**	-0.544*	-0.461*
	(0.362)	(0.247)	(0.366)	(0.248)	(0.381)	(0.281)	(0.255)
BkIncArm	0.027***	0.028***	0.027***	0.028***	0.027***	-0.011	0.028***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.060)	(0.010)
FinShare	-1.510***	-1.424**	-1.481**	-1.404*	-1.499**	-2.284	-1.423*
	(0.590)	(0.719)	(0.589)	(0.719)	(0.597)	(1.538)	(0.729)
SoftInfo	-0.074**	-0.089**	-0.073**	-0.088**	-0.075**	0.005	-0.090**
	(0.031)	(0.037)	(0.031)	(0.038)	(0.030)	(0.052)	(0.037)
LogL	-115.7	-78.3	-379.5	-269.6	-380.3	-102.3	-270.3
AIC	259.5	182.7	791.1	569.2	792.6	232.5	568.5
SBIC	327.5	242.5	868.8	638.1	870.3	279.9	632.9
LRI	0.512	0.542	--	--	--	--	--
Observ.	952	734	952	734	953	218	735
Censored	60	43	60	43	60	17	43

Notes: See previous tables for further details. Columns (1) to (4) exclude those (outlier) relationships that last more than fifty years (600 months); Regressions 1 and 3 consider all the firms; regressions 2 and 4 consider only the medium and small firms. In columns (5) to (7) are considered different change-points; those are, respectively: 225 months for all firms (regression 5); 175 months for large firms (regression 6); and 225 months for medium and small firms (regression 7).

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Figure 1. Survivor functions: all firms

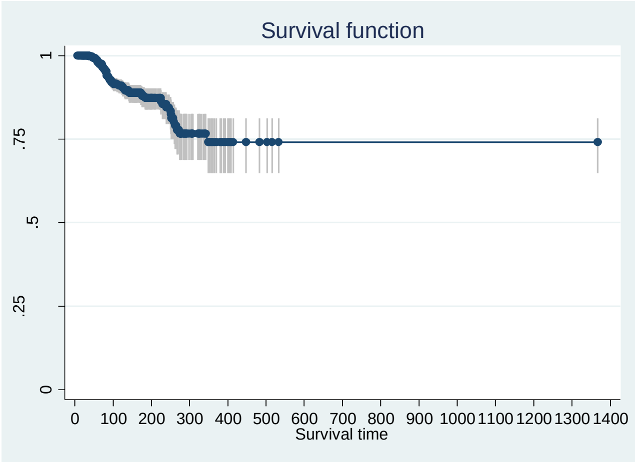


Figure 2. Survivor functions: large firms

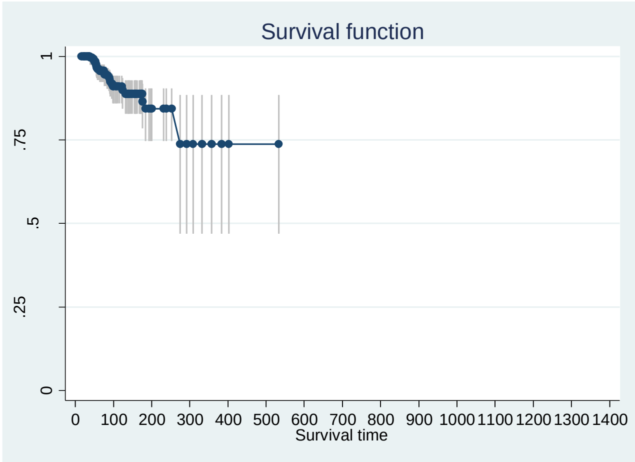
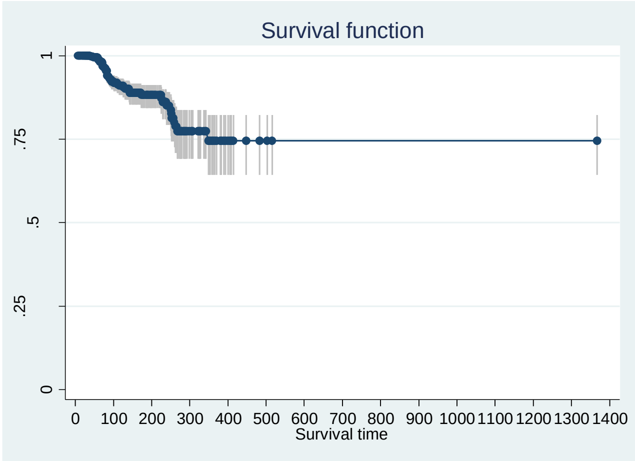


Figure 3. Survivor functions: medium-small firms



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